

ABSTRACTS

Minimally Invasive Versus Conventional Aortic Valve Replacement: Early Clinical Outcome

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Background: Aortic valve replacement (AVR) through a partial sternotomy (MINI-AVR) has been suggested to significantly reduce postoperative morbidity when compared to conventional AVR. This study sought to investigate whether a partial upper sternotomy may yield an improved early outcome over conventional AVR.

Methods: We compared the perioperative outcomes of patients who had MINI-AVR (n=48, 71% males) versus conventional AVR (n=357, 57% males), between January 1997 and February 2000. Patients were included if they had only sole AVR. The two groups were similar with respect to baseline characteristics.

Results: Comparative analysis is summarized in the table below.

	MINI-AVR	Conventional AVR	P
Pump time (min)	110 ± 54	125 ± 78	NS
Cross-clamp time (min)	64 ± 30	80 ± 40	NS
Anesthesia time	4 ± 1	4 ± 3	NS
Mediastinitis	0 (0)	1 (0.3)	NS
Transfusion in OR	13 (27)	189 (53)	0.001
Postoperative transfusions	22 (46)	207 (58)	0.06
Reoperation due to bleeding	1 (2)	12 (3)	NS
Postoperative atrial fibrillation	29 (60)	198 (55)	NS
Postoperative inotropes	8 (17)	77 (22)	NS
Postoperative IABP	0 (0)	9 (2)	NS
Postoperative stay	6 ± 2	7 ± 4	NS
In-hospital mortality	1 (2)	21 (6)	NS

Values are expressed as mean ± SD, or as numbers (%). NS= Non-significant; IABP= Intra-aortic balloon counterpulsation.

Conclusion: Aortic valve replacement can be performed through a partial sternotomy with results comparable to the conventional full sternotomy approach. However, the partial sternotomy offers a cosmetic benefit, preservation of chest wall integrity, and an easy access in case of reoperation.

Atrial Septal Defect Closure Combined with Minimally Invasive Coronary Artery Bypass Surgery Through a Left Thoracotomy

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Introduction: Surgical closure of atrial septal defect (ASD) via the median sternotomy approach is associated with low operative mortality and morbidity. However, in young women the median sternotomy scar is cosmetically unacceptable. In this case, we combined minimally invasive coronary artery bypass surgery (MIDCAB) with closure of an ASD via an anterior left thoracotomy.

Methods: An obese female presented with a significant stenosis of the left anterior descending coronary artery (LAD) and a large ostium secundum defect. Because of the referral physician and insistence of the patient on a small scar, we proceeded to close the ASD and perform a MIDCAB via a left anterior thoracotomy. A small 4-inch left anterior thoracotomy skin incision was made between the 4th and 5th intercostal space. The left internal mammary artery (LIMA) was mobilized. Both the right femoral artery and vein were cannulated and the patient placed on bypass. Through the small chest incision, excellent exposure was obtained of the aorta and superior vena cava. Once the superior vena cava was snared down, the right atrium was opened and the ASD closed rapidly. The LIMA was then anastomosed to the LAD using the CTS retractor and stabilizing system.

Results: The patient had no postoperative complications. A repeat echocardiogram showed complete closure of the ASD. She was discharged from the hospital in 2 days.

Conclusions: Even though difficult, ASD closure and MIDCAB can be approached through a left anterior thoracotomy. The incision is cosmetically acceptable and greatly appreciated by the patient and family.

Minimally Invasive Coronary Artery Bypass Surgery in Coronary Reoperations

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Introduction: Minimally invasive coronary artery bypass surgery (MID-CAB) without the use of cardiopulmonary bypass is being performed in an increasing number of patients. We review our outcomes on 63 consecutive coronary reoperations.

Methods: Over a 2-year period, sixty-three patients with prior coronary artery bypass surgery underwent reoperations using a MIDCAB approach. The majority of these patients had significant contraindications to conventional bypass surgery. The average time interval from the first surgery was 7.9 years. The left internal mammary artery was used in 44 and the right internal mammary artery used in 11 patients. All the anastomosis were performed by temporary local occlusion on a beating heart by support of mechanical stabilizers. Follow up angiograms were obtained in all patients presenting with recurrent chest pain or ECG changes.

Results: The 30-day mortality and morbidity was 6.8%. The mean postoperative length of stay in hospital was 4.5 days. Occlusion of the right coronary artery produced arrhythmias in 39% of patients and femoral-femoral bypass was required in 5 patients. Conversion to an open sternotomy was required in 3 patients. Surgical re-intervention and/or angioplasty were required in 13 patients. Two patients required prolonged intubation and two others developed infection of the chest wall. Overall, 87% of patients were free from angina over 2 years.

Conclusions: Clear advantages of MIDCAB surgery include reduced patient hospital stay, morbidity and mortality. Even though difficult, MID-CAB procedure can be performed in reoperative coronary patients without significant complication rates. The long-term patencies of the grafts still remain to be evaluated.

Beating Heart Surgery in Octogenarians: Perioperative Outcome and Comparison with Younger Age Groups

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Objective: Octogenarians have a higher morbidity and mortality (9–16%) after coronary artery bypass grafting (CABG) with cardiopulmonary bypass, compared with younger patients. We compared the perioperative outcome and hospital stay after CABG without cardiopulmonary bypass (Off-pump), from January 1987 to May 1999, among patients older than 80 years (n=71), patients between 70–79 years (n=228), and patients whose age ranged from 60–69 years (n=296).

Methods: In comparison with younger patients, more octogenarian patients were female (51% versus 39% in age 70 to 79 years and 35% in age 60 to 69 years, p=0.04), they had previous myocardial infarction more frequently (48% versus 47% versus 35%, respectively, p=0.008) and were operated upon urgently (69% versus 56% versus 52%, respectively, p=0.04).

Results: Postoperative complications that were significantly higher in octogenarians, as compared with younger groups included: (1) Pneumonia (6% in octogenarians versus 2% in age 70 to 79 years and 0% in age 60 to 69 years, p=0.001) and (2) atrial fibrillation (47% versus 32% versus 21%, respectively, p<0.001). In multivariate logistic regression analysis, age > 80 years was an independent predictor of prolonged hospital stay (Odds ratio= 2.5, 95% confidence intervals: 1.4 to 5, p<0.001). In-hospital mortality was higher in octogenarians (6% versus 3% in age 70 to 79 years and 0.3% in age 60 to 69 years, p=0.006).

Conclusions: When appropriately applied in patients older than 80 years, Off-pump CABG can be performed with acceptable postoperative morbidity, mortality and hospital stay.

Port Placement Simulation in a Virtual 3-D Thoracic Model

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Background: Surgical robotic systems have recently been introduced to increase the precision of minimally invasive direct coronary artery bypass (MIDCAB) surgery. Despite the success of this approach, surgeons still require better visualization tools for pre-surgical planning, for example, to determine the placement of thoracic ports to acquire optimum access to the target vessels. We discuss our preliminary efforts towards the development of an image-guided surgical system to support robotically-assisted CAB.

Methods: 3-D thorax images acquired with CT and ECG-gated MRI are imported into our surgical planning platform. Using this software, a user may interactively visualize simulated thoracic ports and robotic tools within the thoracic region. We have also implemented a virtual endoscope to simulate the endoscopic view observed by the surgeon during the operation. Once the surgeon determines the port placement for optimal access to the target vessels, she can record the positions of the simulated tools and mark them on the patient for port incisions.

Results: We have used a static thorax phantom to verify the port positions obtained from our simulations. This thorax phantom is used routinely at the London Health Science Centre for robotic coronary bypass training. We measured the physical positions of the ports relative to the surface markers. We then compare these values to our simulated results. The physical distances from the ports to the markers agreed with the simulated results with less than 5mm discrepancies.

Conclusions: Our preliminary image-guided surgical system is able to determine the optimum port placement for a static thoracic model. However, in order to apply this system to a real patient, we need to correct the orientation and positions shifts of the heart and the coronary arteries due to lung deflation and dynamic motions of the beating heart.

The Proximal Anastomosis: A Problem for MIDCAB

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Background: Using a human cadaver model and computer reconstruction of electron beam computer tomography, we examined possible sites for proximal anastomoses.

Methods: Using the ZEUS™ Robotic System and a cadaver model, examination of the LAD and circumflex coronary systems was performed via thoracoscopy. Visualization of the ascending aorta was hindered by the main pulmonary artery. Furthermore, the ascending aorta was deep in the surgical field and trouble with control was anticipated. The proximal portion of the descending thoracic aorta just distal to the left subclavian artery take-off appeared to be accessible.

Results: Using the computer reconstruction, we were able to manipulate 3-D images of this anatomy. The computer model confirmed the problem of access to the ascending aorta from the left chest. We also determined the length from the proximal descending aorta to the left coronary arteries was comparable to the length from the ascending aorta to the left coronary arteries. Right thoracoscopy was used to examine the right coronary arteries and the aorta. The ascending aorta was easily accessed via this approach and appears to be the preferred site. The computer model confirmed this.

Conclusions: The best anatomic site for placement of the proximal anastomosis using a minimally invasive approach is the proximal descending thoracic aorta for the left thoracic approach. The ascending aorta is the best site for the right approach.

Late Neurocognitive Outcome After Beating Heart Surgery Is Decreased by Perioperative Epidural Anesthesia

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Introduction: Epidural anesthesia has been shown to decrease the stress response to surgery and anesthesia. As part of an ongoing study assessing cognitive and neurological dysfunction after cardiac surgery, patients undergoing beating heart surgery (BHS) for coronary revascularization were assessed to determine whether general anesthesia plus employment of continuous epidural anesthesia for 48 hours postoperatively would influence the incidence of cognitive dysfunction.

Methods: Patients receiving epidural anesthesia had a catheter placed between T2 and T4 the night prior to surgery and received ropivacaine for intraoperative and postoperative analgesia, in addition to light general anesthesia, comparable to the control group. A standardized battery of neurocognitive tests were used to determine cognitive performance at baseline (up to 2 weeks preoperatively), at 7 days and at 3 months postoperatively. Change scores were calculated for pre- to postoperative, and pre- to late postoperative periods, and dysfunction was defined as a 20% change from baseline performance on 2 or more tests using unpaired T-test with $p < 0.05$ required for significance.

Results: There was no significant difference in the incidence cognitive dysfunction in the early postoperative period but at 3 months, significantly ($p = 0.0018$) fewer (4 of 19) patients receiving perioperative epidural anesthesia experienced dysfunction compared with the general anesthesia group (15 of 21).

Conclusions: Epidural anesthesia is associated with a lower incidence of cognitive impairment late postoperatively which may reflect suppression of perioperative stress response.

Off-Pump Coronary Artery Bypass In Octogenarians

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Introduction: In octogenarians, coronary artery bypass surgery has been associated with increased mortality and morbidity, especially increased stroke rates. We evaluated off-pump techniques in octogenarians and compared the results with a computer-generated matched control group performed with cardiopulmonary bypass (CPB).

Methods: Between September 1998 and February 2000, 41 off-pump coronary artery bypass (OPCAB) procedures were performed by two surgeons (83.7 years) using a novel cardiac stabilizer which atraumatically incorporates coronary artery occlusion and were compared with 70 octogenarians (82.8 years) using CPB prior to our off-pump experience. Computer-generated matching of co-morbidities was performed and postoperative outcomes were compared.

Results: There were no severe neurologic events in the OPCAB group compared with 8.5% stroke rate in the CPB group. In the OPCAB group, there was a decreased mortality rate (4.9% vs. 7.1%), and reduced atrial fibrillation (14.6% vs. 27%). There was also a significant reduction in length of stay (6.5 vs. 8.8 days, $p < .05$).

Conclusions: Off-pump coronary artery bypass grafting is the preferred approach to myocardial revascularization in the high-risk octogenarian group, with a reduction in stroke rate, mortality, and a significant reduction in length of hospital stay.

Results of Endoscopic Redo Sternotomy

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Introduction: Redo sternotomies are often difficult. There is increased frequency of redo cardiac operations in recent years. We report a technique for redo sternotomy using commonly available equipment.

Methods: We studied prospectively 121 consecutive patients who underwent redo sternotomy at a single institution by the same group of surgeons. Substernal lysis of adhesions was performed using thoracoscopic assisted techniques, followed by a standard median sternotomy.

Results: Mean age at surgery was 71 years, 81% male, 86% were in NYHA Class III or IV, and the ejection fraction was <50% in 64% of the patients. Sixty-four percent of the patients underwent redo coronary bypass grafting and the remainder underwent valve operation with or without coronary bypass. Ninety-four percent survived. There was one injury during redo sternotomy; an innominate vein laceration which was easily repaired. There were no other complications of sternotomy.

Conclusions: Video assisted thoracoscopic lysis of retrosternal adhesions is a safe, simple and reproducible technique. We advocate the use of this technique in all redo cardiac operations.

Coronary Revascularization of the Circumflex System: Different Approaches and Long-Term Outcome

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Introduction: Minimally invasive direct coronary artery bypass, without cardiopulmonary bypass, through a left lateral thoracotomy approach (*lateral MIDCAB*), is a safe alternative to coronary artery bypass surgery on cardiopulmonary bypass (*On-pump CABG*) of the circumflex system via median sternotomy.

Methods: We compared the perioperative outcomes of patients undergoing *lateral MIDCAB* (n=34) versus conventional *On-pump CABG* of the circumflex system (n=16) from June 1996 to July 1999. The two groups were similar with respect to baseline characteristics and risk stratification. Patients who required only one or two grafts for complete revascularization were included.

Results: *Lateral MIDCAB* patients had a lower need than *On-pump CABG* patients for intraoperative (12% *MIDCAB* vs. 43% *On-pump CABG*, $p=0.03$) and postoperative transfusions (29% vs. 69%, $p=0.01$), had fewer neuropsychologic changes (0% vs. 19%, $p=0.03$), and had a lower rate of postoperative atrial fibrillation (12% vs. 44%, $p=0.02$). *Lateral MIDCAB* was also associated with a significantly lower postoperative length of stay (5 ± 2 days vs. 7 ± 3 days, $p=0.02$). Actuarial survival at a mean period of follow-up 19 ± 11 months was 97% for the *lateral MIDCAB* versus 88% for the *On-pump CABG* group ($p=0.1$). Event-free survival was 88% for *lateral MIDCAB* versus 81% for *On-pump CABG* ($p=0.6$).

Conclusions: *Lateral MIDCAB* may safely be performed in patients with isolated coronary artery disease of the circumflex system with improved early morbidity and an abbreviated hospital stay compared with conventional median sternotomy *On-pump CABG*.

Beating Heart Versus Conventional Coronary Artery Bypass in Diabetic Patients

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Objective: Diabetes mellitus is associated with a high morbidity and mortality after conventional coronary artery bypass grafting (CABG) with cardiopulmonary bypass (*On-pump*). The purpose of our study was to investigate whether CABG without cardiopulmonary bypass (*Off-pump*) may yield an improved clinical outcome in diabetic patients who received one or two grafts.

Methods: We compared the perioperative outcomes of diabetic patients who had *On-pump* (n=676) versus *Off-pump CABG* (n=237), between May 1987 and June 1999. Patients were included if they had only one or two vessels bypassed. The two groups were similar with respect to baseline characteristics (Parsonnet score: 21 ± 9 for *On-pump* Vs. 20 ± 10 for *Off-pump*, $p=$ Non Significant [NS]).

Results: Comparative analysis is summarized (table).

	On-Pump	Off-Pump	P
OR PRBC	1.5 \pm 0.6	0.6 \pm 0.2	<0.001
Postoperative atrial fibrillation	209 (31%)	55 (23%)	0.02
Postoperative stay	7 \pm 2	5 \pm 3	<0.001
Postoperative inotropes	140 (21%)	25 (10%)	<0.001
ICU stay	3 \pm 2	2 \pm 2	0.02
Postoperative transfusions	255 (38%)	69 (29%)	<0.001
Postoperative stroke	13 (2%)	1 (0.4%)	NS
In-hospital mortality	42 (6%)	8 (3%)	NS

OR PRBC: Packed red blood cells transfused in the operating room; ICU: Intensive care unit; Post-op IABP: Postoperative intra-aortic balloon pump.

Conclusions: *Off-pump* surgery in diabetic patients who had only one or two vessel bypassed was associated with a lower operative morbidity and abbreviated hospital and ICU length of stay than standard procedure *On-pump CABG*. Mortality in both groups was low (< 6 %).

The Octopus® II Stabilizer: Preliminary Biochemical and Neuropsychological Outcomes from a Prospective Randomised Trial

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Introduction: The aim of this study was to determine if coronary artery bypass graft (CABG) surgery performed utilizing the Octopus® II retraction system provides myocardial and cerebral protection comparable to traditional CABG surgery utilizing cardiopulmonary bypass (CPB).

Methods: Elective patients requiring surgery for double or triple vessel disease were randomised to receive either conventional CABG with CPB (n=10) or off-pump CABG using the Octopus® II retraction system (n=9), after receiving institutional approval and written consent. Exclusion criteria included previous cardiac surgery, recent myocardial infarction, and previous cerebrovascular disease. Troponin T was measured preoperatively, and at 2, 4, 6, 8, 10, 12, 24, and 72 hours after initiation of grafting. Neuropsychological assessments (10 measures) were performed in the week prior to surgery and one week after surgery.

Results: Troponin T release was reduced in the Octopus® II patients at all time points (repeated measures ANOVA $p=0.091$), reaching significance at 12 hours ($p=0.038$). Other factors (composite clinical end point (prolonged LOS or ICU stay or 30d mortality), infarction, and intubation time) did not show any significant differences. Neuropsychological evaluation identified a higher incidence of decline on the Digit Symbol sub-test (WAIS-R) in patients undergoing traditional bypass compared to Octopus® II patients (40% vs 0%, $p=0.033$).

Conclusions: Decreased Troponin T release suggests a myocardial benefit for the Octopus® II off-pump procedure. Demonstration of a neuropsychological benefit remains to be determined.

Cardiopulmonary Bypass as an Independent Predictor of Cerebral Events in Coronary Artery Bypass Grafting

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Introduction: Cerebral complications represent serious causes of morbidity and mortality after cardiac surgery. Abolishing cardiopulmonary bypass (CPB) during coronary artery bypass grafting (CABG) on the beating heart allowed us to assess the hazard of adverse cerebral outcome associated with a type of surgical technique used for coronary revascularisation.

Methods: A cohort of 805 consecutive CABG patients, 199 without CPB and 606 with CPB, were studied. Cerebral complications consisted of: (1) persistent neurological focal deficits, (2) prolonged coma lasting more than 24 hours, (3) temporary neurological focal deficits or (4) delirium. Cerebral injury was defined as cerebral complications excluding delirium. Multivariate logistic regression analysis was carried out to assess the independent association of potential risk factors with adverse cerebral events.

Results: Cerebral complications occurred in 51 patients (6.3%) and cerebral injury in 19 patients (2.4%). Independent predictors of risk for cerebral complications were the use of CPB (odds ratio 5.2, 95% CI 1.6–17.5), carotid bruits (odds ratio 3.5, 95% CI 1.5–8.2), advanced age (odds ratio 1.1, 95% CI 1.0–1.1) and peripheral vascular disease (odds ratio 2.5, 95% CI 1.1–5.8). Negative cerebral outcome was more common in the CPB-group, varying from 2.4 for TIA, to 12 for delirium.

Conclusions: The contribution of CPB to the occurrence of cerebral complications after CABG appears significant. This study confirms the beneficial effect of excluding the use of CPB during CABG in order to avoid cerebral complications, especially if concomitant risk factors like advanced age, carotid bruits and peripheral atherosclerosis are present.

Retaining the Aortic Fat Pad During CABG Decreases Post Operative Atrial Fibrillation

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Introduction: Atrial arrhythmias are a common and serious complication of cardiac surgical procedures. Reports describing pericardiac neurogenic tissue led us to hypothesize that removal of the aortic fat pad could cause an autonomic imbalance and contribute to atrial fibrillation (AF) following cardiac surgery.

Methods: Patients (n=131) underwent either conventional CABG or OPCAB. The aortic fat pad was left intact or removed by random determination. The incidence of *de novo* AF during the patient's hospital stay was tabulated. Patients with peri-operative myocardial infarction or pre-existing supraventricular arrhythmias were excluded.

Results: Demographics, preoperative medications, ASA and NYHA classifications and complication rates (other than AF) did not differ among the groups. The STS predicted mortality was higher in the on pump/fat pad removed group (2.23 ± 1.89) vs. either OPCAB/fat pad intact (1.09 ± .80) or OPCAB/fat pad removed (1.02 ± 0.62) groups (P<0.05). Logistic regression demonstrated a significantly elevated AF rate when the fat pad was removed (Odds ratio 3.49, 95% bounds 1.09 to 11.18, p = 0.035). Neither the pump status nor the cross product of pump status by fat pad status were significant in this pilot study.

Conclusions: Retaining the aortic fat pad during CABG surgery is correlated with a decreased incidence of post operative AF.

Alternative Approaches in Off-Pump Redo Coronary Artery Bypass Grafting

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Introduction: The recent development of off-pump and minimally invasive techniques in CABG has provided the surgeon with multiple options in performing redo revascularization procedures.

Methods: We retrospectively analyzed our early results in off-pump redo CABG procedures. Between Jan. 1998 and Jan. 2000, we performed 55 off-pump redo CABG procedures: 25 through a full sternotomy, 21 through a left posterolateral thoracotomy, 5 using a lower hemi-sternotomy and 4 using a mini anterior thoracotomy with endoscopic IMA harvesting. The mean age of this group was 67.7 years (range 37–85). The mean number of grafts performed in earlier operations was 2.7 (range 1–6) with 51% of grafts still partially or fully open at the time of re-operation. Twenty-six patients (47.3%) had a functioning LIMA graft to LAD. Preoperative clinical severity scoring predicted a mortality of 7% and morbidity of 30%.

Results: There were no operative or thirty-day infarctions or deaths. Morbidity included pulmonary complications (8), renal failure (1) and bleeding (1) for a total complication rate of 18.9%. The average number of grafts performed was 2.7 (range 1–5) for sternotomy patients and 1.4 (range 1–3) for thoracotomy patients.

Conclusions: By employing alternative approaches in performing off-pump redo CABG procedures, the surgeon can often avoid injury to pre-existing patent internal mammary grafts as well as the morbidity associated with the use of cardiopulmonary bypass.

Computer Enhanced Mitral Valve Surgery: An Animal Model

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Introduction: Over a short time, computer-assisted robotic devices have been shown to enable less invasive cardiac surgery. We studied the feasibility of performing mitral valve repairs using the da Vinci™ robotic surgical system (Intuitive Surgical, Mountain View, CA).

Methods: Nine sheep weighing 50–60kg were euthanized. A 5 cm right mini-thoracotomy incision was made, and the fourth intercostal space was entered. A zero degree three-dimensional videoscope was inserted through the incision. Posterior to the incision and through the same intercostal space, two 10 mm port incisions were made for insertion of the two robotic arms. A left atriotomy provided access to the mitral valve. The surgeon worked at the master console located 10 feet from the operating table. A flexible annuloplasty ring was sutured between fibrous trigones along the posterior annulus using 6 cm double armed 3-0 Ticon suture. Parameters studied included: set-up time, time for individual suture placement, number of sutures used, and total repair time.

Results: Set-up time for the robotic system averaged 9.0 ± 0.5 minutes (mean ± s.d.). Time for individual suture placement was 4.0 ± 1.6 minutes, and the number of sutures required for each repair was 8.4 ± 0.5. The total time for annuloplasty ring placement was 39.7 ± 7.6 minutes.

Conclusions: Length of time for mitral valve repair is similar to historical controls. Computer enhanced telemanipulative surgery adds precision and dexterity, enabling complex procedures via minimally invasive approaches. The wrist-like 2 mm instrument tips provide seven degrees of freedom, enabling access to subvalvular structures and facilitate suture placement in difficult anatomic positions. Robotic technology may prove beneficial toward enabling complex intracardiac procedures using less invasive approaches. A short video clip will be presented.

Transmyocardial Revascularization Combined with Minimally Invasive Coronary Artery Bypass Surgery

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Introduction: To evaluate the effectiveness of transmyocardial revascularization (TMR) combined with minimally invasive coronary artery bypass (MIDCAB) in patients not amenable to complete revascularization by coronary artery bypass alone.

Methods: Eighteen patients with significant comorbidities underwent a combined MIDCAB plus TMR to ischemic areas not graftable. A small left anterior thoracotomy was performed followed by mobilizing the left internal mammary artery (LIMA). In all patients, the LIMA was anastomosed to the left anterior descending coronary artery. The anastomosis was performed on the beating heart by support of pressure stabilizers. TMR was then performed using the Holmium Eclipse Laser System.

Results: There was no early or late postoperative mortality. Major 30-day complications included respiratory failure and an infection around the anterior thoracotomy skin incision (n = 1) and myocardial infarction (n = 2). The mean duration of surgery was 2.4 hours and all patients were extubated on the same day. The mean postoperative blood loss was 366cc and only 4 patients required blood transfusions postoperatively. All patients except 2 were discharged after 3.3 days. At 3 months, the majority of patients were free of angina episodes.

Conclusions: Our study shows that TMR plus MIDCAB is a safe, cost effective and is associated with excellent clinical outcomes.

Preliminary Experience with a New Enabling Technology for Single Step Aorta to Graft Anastomosis without Side Clamp During OPCAB Procedures: Work in Progress

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Background: Recent investigations point to several potential causes of cognitive dysfunction following CABG including various forms of on and off-pump (side clamp) aortic manipulation. Heavy atherosclerotic disease, calcification, and ectasia also increase the risk for mechanical aortic damage during manipulation. Our goal was to design a system for one step creation of the aorta to graft anastomosis suitable for multi-vessel CABG procedures that did not require a cross or side clamp to be applied to the aorta. This system also allowed creation of the anastomosis at a distance from the operator, at any site on the thoracic aorta.

Methods: The anastomotic technology was evaluated during 10 acute pig studies. A total of 10 aortic anastomoses were made on fully pressurized aortas, and distal anastomoses to the LAD made in 6. The anastomotic technology is comprised of a stent-like collar and sleeve anchoring implant coupled to either Seldinger (7 implantations) or trocar based (3 implantations) delivery subsystems. If required, the trocar system allows creation of the anastomosis through a portal access.

Results: All anastomotic attempts were successful. Peak systolic aortic pressures of up to 180 mmHg were induced. There were no episodes of leakage, acute dehiscence, or other proximal anastomotic failures.

Conclusions: The anastomotic system presented functioned well in acute animal studies. The technology has potential to allow multi-vessel OPCAB procedures while significantly reducing aortic manipulation by eliminating the need for side clamping of the aorta. There is also potential to eliminate all risks of damage to the ascending aorta and of brain due to emboli by creation of the proximal anastomoses at the aortic arch or descending aorta. Long-term animal studies are underway.

Clinical Investigation: Endoscopic Coronary Artery Bypass Grafting (E-CABG™) with Robotic Assistance

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Introduction: The current study reviews recent clinical feasibility experiences, which employ the results of our previous cadaveric study, that evaluate safety and efficacy of using the ZEUS™ Robotic Surgical System (Computer Motion Inc., Goleta, California, USA) to create a left internal mammary artery (LIMA) to left anterior descending (LAD) artery anastomosis.

Methods: Between August and November 1999, nine patients ranging in age from 54 to 73 (mean of 64.89) underwent an E-CABG™ using robotic assistance, following IRB approval and informed consent. Five procedures consisted of an off-pump coronary artery bypass portion (performed on each vessel, except the LAD) followed by a stopped heart LIMA to LAD anastomosis portion, the latter is according to the protocol approved and governed by the U.S. Food and Drug Administration (FDA). ZEUS™ was transthoracically introduced in the 4th, 5th, and 6th intercostal spaces. The LIMA to LAD anastomoses were endoscopically constructed with robotic assistance. LIMA grafts were intraoperatively assessed by flow measurement and visual inspection.

Results: Each of the nine endoscopic LIMA to LAD anastomoses were performed robotically, without the necessity for intraoperative intervention with traditional techniques. Robotic anastomosis times averaged 29.05 minutes (ranging from 21.9 to 43). Total time the robotic system added to the entire procedure averaged 41.28 minutes (ranging from 35.35 to 52). LIMA flows prior to anastomoses measured from 11.2 to 29.2 mL/min (mean of 21.62). LIMA flow measurements following anastomoses averaged 41.9 mL/min (ranging from 21.2 to 66). The average cross clamp time was 55.54 minutes. There were no deaths, perioperative myocardial infarctions, or postoperative explorations for bleeding.

Conclusions: While E-CABG™ is an exhaustive and technically demanding procedure, it is feasible for a computer enhanced robotic telemanipulation system to provide substantial assistance in performing extensive endoscopic procedures. The ZEUS™ system safely and effectively facilitates the surgeon to complete a thoracoscopic coronary anastomosis.

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